Wheat and Other Small Grains Research Needs in the Southern Region - 1974

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WHEAT AND OTHER SMALL GRAINS
RESEARCH NEEDS IN THE
SOUTHERN REGION

1974

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Prepared by:

A joint Task Force of the Southern Region Agricultural Experiment Stations and United States Department of Agricultural research scientists with counsel from commercial representatives.

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INTRODUCTION

The Southern Region is composed of the thirteen contiguous states bounded on the north and west by Virginia, Kentucky, Arkansas, Oklahoma and Texas; plus Puerto Rico and the Virgin Islands. In 1973, small grains were planted on approximately 17 million acres in the Southern Region and the value of grain production was over 1 billion dollars. In addition, millions of dollars were realized from forage and grazing of the small grain crops. Significant advances in small grain production have been made by improving varieties and management practices, but ever increasing demands for food and feed resources require expanded and intensified research efforts on small grains in the south.

Characteristics of the Region

Wheat and other small grains contribute substantially to the total agricultural output and subsequent economy of the southern region (Tables 1 and 2). The southern region of the United States produces about 18 percent of the nation's winter wheat supply. Approximately 70-75 percent of the crop consists of hard red winter varieties used for bread making and 25-30 percent of soft red winter varieties which mills a soft family flour highly suitable for home baking and the production of cookies and crackers. The flour also blends well with the high protein flours from hard red winter and spring wheats for bread making.

The cultivation of hard red winter wheat is concentrated on large highly mechanized farms on the plains of Oklahoma and Texas (Figure 1). The area is characterized by hot summers and cold dry winters. The annual precipitation fluctuates widely and drought years are not uncommon. In general, soil moisture supply is the most limiting factor to production, and to conserve it, a year of wheat is preceded by a year of occassionally fallow. The extent of loss resulting from moisture shortage was evident on the Texas plains in 1972. Adequate moisture in the fall allowed the crop to make excellent early progress but a drought period extending from January into April caused severe deterioration of the crop. That year irrigated (about 29 percent of the acreage) and non-irrigated land produced a state average of 40.3 and 16.7 bushels per acre, respectively.

The cultivation of soft red winter wheat is distributed across the southern region from Northeast Texas to the Atlantic Coastal Plains (Figure 2). Temperature fluctuations are narrower than those on the Southern Great Plains and the average annual precipitation usually exceeds 40 inches (Figure 3). A widely diversified agriculture exists throughout the area. Wheat is grown in various rotations with other crops such as maize, clover, alfalfa, grasses, or soybeans.

Differences in climate and cropping systems between the hard red and soft red winter wheat areas create different ecological areas with their own peculiar production hazards. Certain pests that rank high in loss priority in one area are of little economic importance in the other. For example, wheat streak mosaic is among the most serious diseases in the hard red winter wheat area, but is not economically important in the

Table 1. Average Acreage Harvested and Production of Wheat, Oats, Barley and Rye from States in the Southern Region for 1971-73.

State	Wheat		Oats		Barley		Rye	
	Harvested Acres	Prod.	Harvested Acres	Prod.	Harvested Acres	Prod.	Harvested Acres	Prod.
	1,000 A.	1,000 bu.	1,000 A.	1,000 bu.	1,000 A.	1,000 bu.	1,000 A.	1,000 bu.
Oklahoma	4,253	106,500	171	6,377	358	10,640	58	1,124
Texas	2,299	58,005	411	14,121	72	2,270	32	552
North Carolina	202	7,445	88	4,522	65	3,094	14	294
Virginia	100	7,854	46	2,046	103	4,788	17	414
Kentucky	187	6,544	14	648	62	2,755	3	80
Tennessee	206	6,856	32	1,390	20	718	2	45
South Carolina	121	3,344	77	3,394	27	1,100	31	627
Georgia	152	4,548	72	3,403	15	575	92	1,688
Florida	44	1,030	14	549	-	-	-	-
Alabama	106	2,568	25	961	-	-	-	-
Mississippi	128	3,762	29	1,325	-	-	-	-
Louisiana	28	630	12	535	-	-	-	-
Arkansas	257	8,375	78	5,034	1	28	-	-
TOTAL								
Southern Region	8,181	217,458	1,069	44,311	724	25,968	249	4,826
All States	49,611	1,624,708	14,469	745,703	10,128	437,182	1,292	34,956

SOURCE: Statistical Reporting Service, U.S.D.A 1973 Annual Summary, Jan. 16, 1974.

Table 2. Value of 1973 Production of Wheat, Oats, Barley and Rye from States in the Southern Region.

State	Value of Production (1,000 Dollars)			
	Wheat	Oats	Barley	Rye
Oklahoma	583,860	9,147	12,408	2,133
Texas	315,520	29,315	5,265	940
North Carolina	15,400	4,125	4,278	479
Virginia	18,778	2,029	6,909	720
Kentucky	16,507	580	2,791	81
Tennessee	12,722	1,392	651	74
South Carolina	6,944	3,427	1,451	1,163
Georgia	8,748	4,375	896	3,703
Florida	1,716	543	-	-
Alabama	5,465	814	-	-
Mississippi	7,425	880	-	-
Louisiana	1,049	361	-	-
Arkansas	16,405	4,054	-	-
TOTAL				
Southern Region	1,010,539	61,042	34,649	9,293
All States	6,825,373	769,126	893,390	47,599

SOURCE: Statistical Reporting Service, U.S.D.A. Field Crops, May 10, 1974.

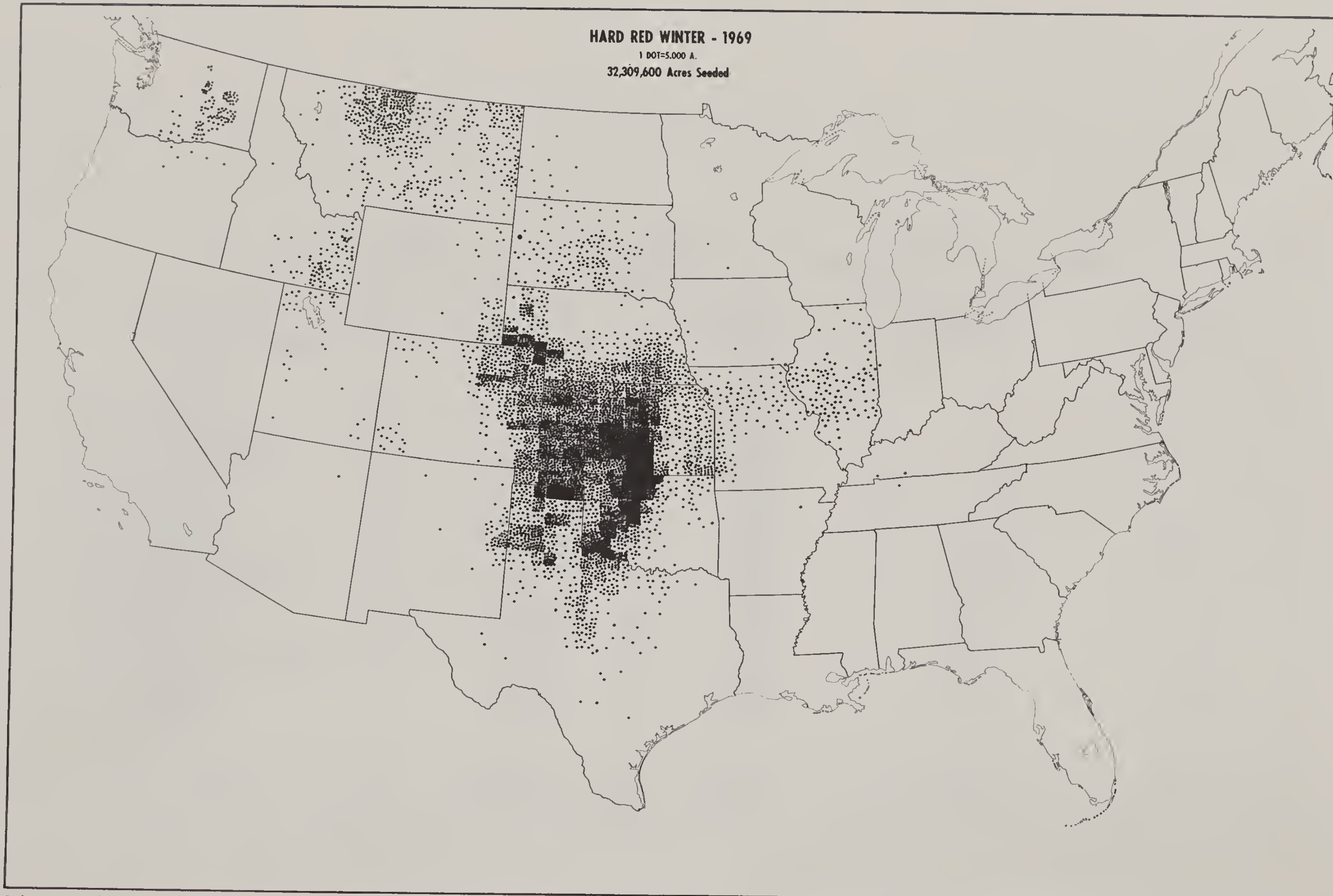

Figure 1. Distribution of hard red winter wheat in 1969. Estimated area, 32,309,600 acres. Each dot represents 5,000 acres.

Source: Distribution of the varieties and classes of wheat in the United States in 1969, (U.S. Department of Agriculture, ARS, Statistical Bulletin No. 475.)

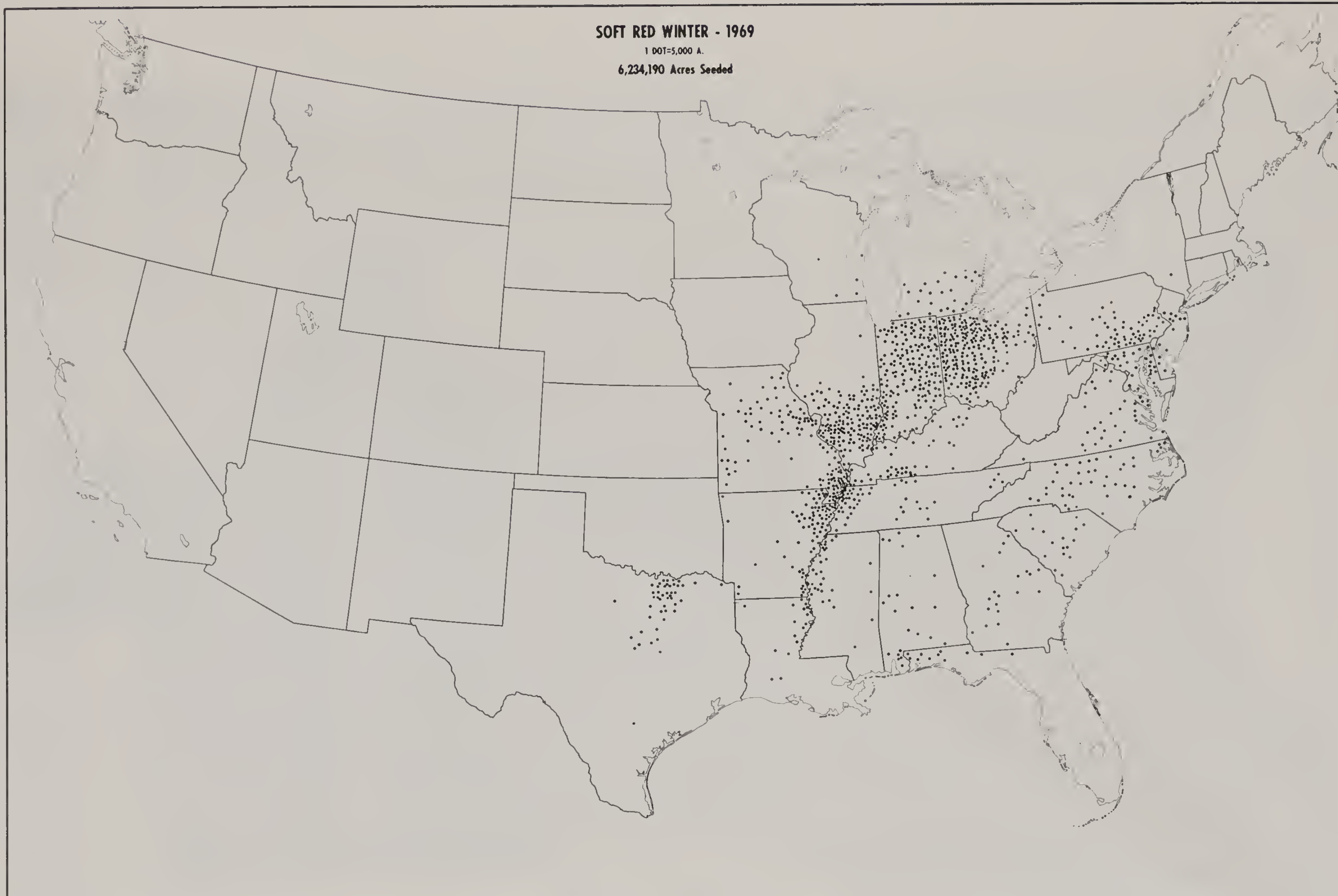

Figure 2. Distribution of soft red winter wheat in 1969. Estimated area, 6,234,190 acres. Each dot represents 5,000 acres.

Source: Distribution of the varieties and classes of wheat in the United States in 1969, (U.S. Department of Agriculture, ARS, Statistical Bulletin No. 475.)

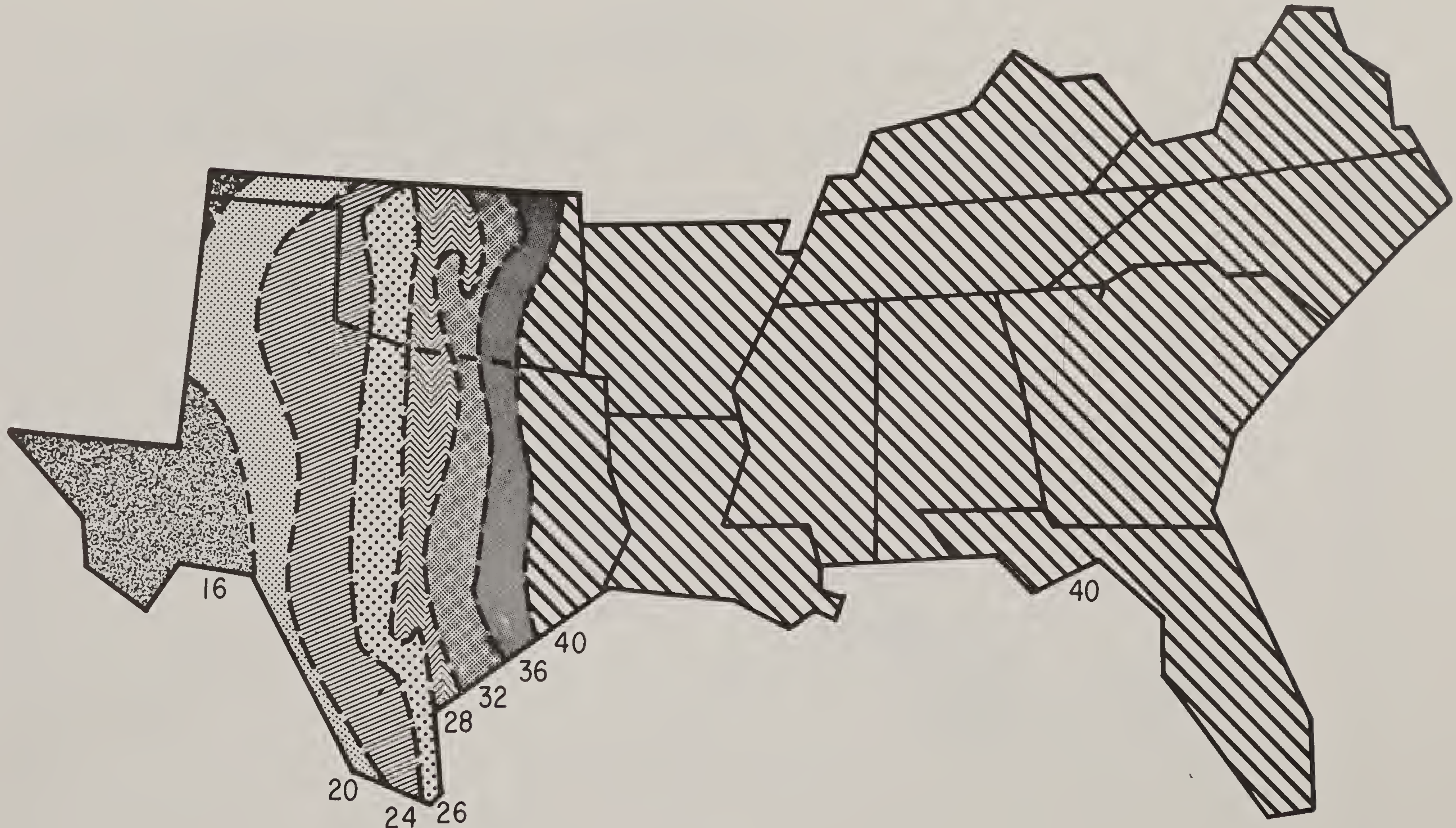

Figure 3. Normal annual total precipitation in the southern region. Precipitation in all states east of Texas and Oklahoma exceeds 40 inches per year.

Source: <u>Climatic Atlas of the United States</u>, June 1968, (U.S. Department of Commerce, Environmental Data Service).

soft wheat area. Conversely, scab and glume blotch commonly occur in the soft wheat area but are seldom observed in the hard wheat area of Texas and Oklahoma.

Oats are both a grain and a forage crop in the Southern Region. While considerable progress has been made in yield, straw strength, disease resistance, and winter hardiness, there is a continuing need for research efforts to further improve the crop. Diseases such as barley yellow dwarf and crown rust still cause major reductions in yield. Oat types combining increased winter hardiness with desirable agronomic traits are needed to provide the most assured production in the northern parts of the Region. Discovery of a very high protein potential in oats has raised the possibility that oats may become a significantly more valuable commodity than it has been in the past. The yield, quality and balance of amino acids in oats merits increased attention. Many new oats have exceptionally strong straw capable of significantly reducing lodging under intensive production. But an ideal plant type which will respond to these conditions with greatly increased yield is not yet a reality. The greatest challenge to oat workers may be to interrelate the genetics, the biochemistry, and the advantage of the yield potential inherent to the species.

Barley production is concentrated in the northern portions of the Southern Region. Barley is utilized mainly as a feed grain and its relatively early maturity makes it especially useful in double-cropping systems. However, there is exploratory work underway on the development of varieties suitable for malting purposes. Diseases continue to cause significant losses in barley. Barley yellow dwarf, leaf rust, mildew, smut, and scald are continuing problems. In the absence of mercury seed treatments, such fungal diseases as net blotch, spot blotch, and barley stripe have become problems which require more intensive investigation. Aluminum toxicity is a major problem in barley production on the highly acid soils common throughout much of the region. This problem can be addressed both by improving cultural conditions and by utilizing available resistance to aluminum toxicity. Seed size has been shown to be a critical component of barley yield. Further studies of this important character are needed. As with wheat and oats, a strong regional testing program is essential to progress.

Rye is an important forage and grain crop in the south, but has received little research attention. Rye forage to support the vast beef and dairy industries in the south merits expanded research effort. Seed deterioration and diseases and insects losses must be reduced for maximum production. The possibilities of hybrids or strains crosses offer potential increases in forage production and need further investigation. Improvement in protein content, vitamin content, and amino acid balance of rye forage must be made. The development of low alkylresorcinal types would improve the food and feed value of rye grain.

Triticale is a wheat-rye amphiploid species that was recently introduced into the U.S. It is currently grown on a very limited acreage. Triticale appears to have potential value as a feed grain and forage crop if adapted productive varieties can be developed. Seed shrivelling,

spike fertility, and winterhardiness are problems that must be solved before it can be utilized to any extent in the south. Triticale offers a possibility for substantial improvement in nutritional quality. Types with high grain protein and lysine levels are available as breeding stock and should be examined.

Small grains comprise an important source of winter forage in the Southern Region. These crops can be grazed during the winter from October through April when no other green forage crops are available to livestock. Small grain varieties differ markedly in forage characteristics, but in the past little attention has been paid to forage improvement since most small grain varieties have been bred and developed for grain production. In 1972 a small grain forage improvement program was started in Texas. This work should be continued and expanded. Effective methods and procedures for evaluating breeding lines for forage value need to be developed as a first step in forage improvement. Preliminary work in Oklahoma indicates that leaf rust infection restricts root development and greatly reduces regrowth potential after grazing. The effects of other disease and insect pests on forage production should be investigated.

Current Allocation of Scientific Resources

Currently, 61.7 SMY's are allotted 12 research problem areas (RPA's) (Tables 3 and 4). The southern SAES support reflects the national trend in that it devotes a high proportion of effort to biological efficiency (RPA 307) and disease control (RPA 208); whereas, 39.5 percent of the USDA support is concentrated on quality maintenance (RPA 408). State-by-state distribution of SMY's, projects, and 1973 production values are shown in Tables 5 and 6. The Task Force recognizes that the 1973 values may be inflated since the basic provision of the Agricultural Consumer Protection Act of 1973 (S. 1888) sets the 1974-75 target price for wheat at $2.05 and correspondingly lower prices for oats, barley, and rye. However, they are useful for ascertaining relative values.

Supporting Existing Programs

Despite pressures to obtain funding for new programs, the task force strongly recommends that the highest priority in obtaining new funds be placed on "shoring up" existing programs. Many existing programs were originated during a time period when $30,000/year was considered adequate financing for one SMY. Anywhere from $55,000 to $100,000 annually is required now to support one SMY.

While some increase in SMY's is indicated in this report, the general recommendation from this task force is that <u>there should be substantial increases in funding with relatively small increases in SMY's.</u>

Interdisciplinary Programs

There is an increasing need for interdisciplinary programs. While it is sometimes difficult to indicate the need for interdisciplinary programs with the CRIS system, the task force recognizes the importance

Table 3. Scientist Man-Years (SMY) Allocated to Wheat Research Problem Areas (RPA) by State Agricultural Experiment Stations and the U.S. Department of Agriculture in the Southern Region and Nationally.

RPA		Southern Region		National	
Title	No.	SAES	USDA	SAES	USDA
Insects	207	1.4	2.3	6.7	13.1
Diseases	208	3.5	1.9	22.6	17.9
Weeds	209	0.3	0.0	5.2	0.7
Biological Efficiency	307	10.4	0.5	56.5	10.6
Mechanization	308	0.1	1.0	0.9	1.0
Management Systems	309	.8	0.0	1.3	1.0
Acceptability	405	1.2	0.0	6.3	10.0
New Improved Food Prod.	406	0.1	0.0	4.5	18.3
New Improved Non-Food Prod.	407	0.0	0.0	0.0	17.6
Quality Maintenance	408	0.0	11.1	6.2	15.0
Grades and Standards	501	0.0	1.5	0.0	6.9
Marketing Efficiency	503	0.4	0.5	3.7	1.0
TOTAL		18.2	18.8	113.9	114.0

Source: Inventory of Agricultural Research FY 1972 (Cooperative State Research Service and U.S. Department of Agriculture).

Table 4. Scientist Man-Years (SMY) Allocated to Small Grains Other than Wheat Research Problem Areas (RPA) by State Agricultural Experiment Stations and the U.S. Department of Agriculture in the Southern Region and Nationally.

RPA		Southern Region		National	
Title	No.	SAES	USDA	SAES	USDA
Insects	207	0.9	0.8	2.6	6.5
Diseases	208	5.2	1.1[1]	11.5	10.1
Weeds	209	0.2	0.0	3.0	0.1
Biological Efficiency	307	12.5	0.1	43.8	8.5
Mechanization	308	0.1	0.4	0.5	0.4
Management Systems	309	0.1	0.0	0.3	0.0
Acceptability	405	0.1	0.0	3.3	6.4
New Improved Food Prod.	406	0.0	0.0	0.3	0.0
New Improved Non-Food Prod.	407	0.0	2.4	1.3	3.0
Quality Maintenance	408	0.0	0.3	1.2	0.3
Grades and Standards	501	0.0	0.0	0.0	1.5
Marketing Efficiency	503	0.4	0.1	0.8	0.7
TOTAL		19.5	5.2	68.6	37.5

Source: Inventory of Agricultural Research FY 1972 (Cooperative State Research Service and U.S. Department of Agriculture).

[1] Reflects loss of 1 SMY resulting from demise of scientist at Raleigh, North Carolina.

Table 5. Number of Projects and Scientists Man-Years (SMY) Allocated to Wheat and Other Small Grains by State Agricultural Experiment Stations and the U.S. Department of Agriculture in the Southern Region.

	SAES		USDA		Total	
	No. Proj.	SMY	No. Proj.	SMY	No. Proj.	SMY
Oklahoma	39	7.6	14	5.9	53	13.5
Texas	28	6.9	1	.5	29	7.4
North Carolina	15	2.1	-	-	15	2.1
Virginia	8	2.5	-	-	8	2.5
Kentucky	6	2.3	-	-	6	2.3
Tennessee	14	2.3	-	-	14	2.3
South Carolina	13	1.6	-	-	13	1.6
Georgia	17	3.8	15	10.4	32	14.2
Florida	24	2.8	6	4.1	30	6.9
Alabama	5	1.6	16	1.4	21	3.0
Mississippi	13	.7	1	.2	14	.9
Louisiana	11	1.4	1	1.5	12	2.9
Arkansas	9	2.1	-	-	9	2.1
TOTAL	202	37.7	54	24.0	256	61.7

Source: Inventory of Agricultural Research FY 1972 (Cooperative State Research Service and U.S. Department of Agriculture).

Table 6. Value of 1973 Production of Wheat, Oats, Barley and Rye from States in the Southern Region and Ratios of these Values to Total Scientist Man-Years (SMY) Allocated to these States by State Agricultural Experiment Stations and the U.S. Department of Agriculture.

State	1973 Value Production	Total SMY	Value/SMY
	1,000 Dollars		Dollars
Oklahoma	607,548	13.5[1]	45,003,550
Texas	351,040	7.4	47,437,830
North Carolina	24,282	2.1[2]	11,562,850
Virginia	28,436	2.5	11,374,400
Kentucky	19,959	2.3	8,677,820
Tennessee	14,839	2.3	6,451,730
South Carolina	12,985	1.6	8,115,620
Georgia	17,722	14.2	1,248,020
Florida	2,259	6.9	327,390
Alabama	6,279	3.0	2,093,000
Mississippi	8,305	.9	9,227,770
Louisiana	1,410	2.9	486,200
Arkansas	20,459	2.1	9,742,380
TOTAL	1,115,523	61.7	180,797,893

[1] Includes two SMY's formerly located in Texas.
[2] Reflects loss of 1 SMY resulting from demise of scientist.

of such efforts and recommends that both SAES and USDA-ARS administrators provide an atmosphere which encourages planning and cooperation between disciplines. The extensive reorganization of ARS in 1972 has opened the door for more interdisciplinary programs and better joint federal-state cooperation in such programs providing administrators recognize and support such opportunities.

Procedure and Summary

The Task Force was charged with 1) determining present levels of support, 2) proposing an allocation of SMY's to RPA's assuming a limited increase in funding, and 3) proposing the allocation of SMY's to RPA's needed to solve major problems in a ten year period.

Table 7 presents a summary of present and projected allocations of SMY's to RPA's. The Task Force considers its projections to be conservative and the support of these efforts imperative.

Inasmuch as many researchable problems related to producing small grains have been recognized but unsolved for many years, this Task Force relied heavily upon certain recommendations presented in A National Program of Research for Wheat and Other Small Grains prepared in 1969 by a Joint Task Force of the U.S. Department of Agriculture, State Universities, and Land Grant Colleges.

Table 7. Summary Table Showing Allocations of SMY's to RPA's under Different Levels of Funding.

RPA		Current Allocation 1972		Proposed Allocation for Southern Region	
Name	No.	National	Southern Region	With limited increase	To solve problems in 10 yrs.
Insects	207	28.9	5.4	6	18
Diseases	208	62.1	11.7	15	36
Weeds	209	9.0	.5	1	5
Biological Efficiency	307	119.4	23.5	26	49
Mechanization	308	2.8	1.6	2	6
Management Systems	309	2.6	.9	2	6
Acceptability	405	26.0	1.3	2	5
New Improved Food Prod.	406	23.1	.1	1	2
New Improved Non-Food Prod.	407	21.9	2.4	2	4
Quality Maintenance	408	22.7	11.4	5	12
Grades and Standards	501	8.4	1.5	2	6
Marketing Efficiency	503	7.1	1.4	2	13
TOTAL		231.4	61.7	66.0	162.0

CONTROL OF INSECT PESTS

RPA 207

Situation

Wheat and other small grains in the Southern Region are attacked by more than 100 species of insects from planting time until harvest. There are subterranean pests such as wireworms and false wireworms destroying germinating seed and seedlings, white grubs feeding on roots, and cutworms severing plants near the ground surface. Attacks by soil insects are especially difficult to predict and control at present. However, most insect pests, including aphids, leafhoppers, plant bugs, and mites, attack the foliage of small grains and extract the plant liquids. Others including grasshoppers, flea beetles, thrips, cereal leaf beetles, armyworms, and stalk borers chew foliage and developing seed heads (wheat strawworm). Still others, such as the Hessian fly larvae and wheat jointworms, develop inside stems. Frequently in a given field, a chronic complex of pests exists with each species taking a small annual yield toll. In addition, there are sporatic outbreaks which under certain climatic conditions devestate large acreages unless emergency controls are applied. Conditions favoring such outbreaks as those of greenbugs and armyworms have not been studied to any extent.

Direct damage by insects to small grains in the United States was estimated at $200 million in 1968. In addition to direct feeding damage from pests, there are indirect losses more difficult to appraise. These include reducing plant vigor which may increase susceptibility to drought, enhance damage by diseases, or afford unfavorable competition with weeds; lodging of plants, and consequential harvesting problems; and reduction of quality in both forage for livestock grazing and grain used for human and animal food. Also, some aphids, leafhoppers, and mites are efficient vectors of viruses causing yellows and mosaic diseases.

Objective

To obtain sufficient information to accurately predict and economically control insect pests so that losses will be minimal.

Researchable Problems - 18 SMY

A. Obtain additional information on the taxonomy, biology (life cycles and biotypes), ecology (abundance in relation to environment, migration, and host range), and physiology (nutrition, mass rearing, and diapause).
3.4 SMY

B. Determine the economic importance of insects and develop economic thresholds for major pests.
1.7 SMY

C. Establish cultural practices such as tillage, fertilization, crop rotation, time of planting, and harvesting procedures conducive to insect pest reduction but compatible with other components of yield.
.8 SMY

D. Locate, transfer, and develop plants resistant to insect pests, and determine the mechanism, nature, and inheritance of resistance in cooperation with other scientific disciplines.
3.4 SMY

E. Evaluate the effectiveness of both native and introduced parasites, predators, and pathogens; and study the feasibility of mass production and dissemination of these agents.
1.7 SMY

F. Develop and evaluate insecticides with improved application equipment for influence on pests and beneficial insects and environmental compatibility.
1.7 SMY

G. Investigate chemosterilants, radiation, and physical and chemical stimuli for control possibilities or perhaps eradication.
1.7 SMY

H. Study biological aspects of foreign insects to prevent introduction and spread.
1.0 SMY

I. Establish a computerized system analysis and develop pest management schemes involving all control practices and relationships with other crops.
2.6 SMY

Potential Benefits

Conventional Studies of taxonomy, biology, ecology, and physiology offer support to applied aspects of entomology and may uncover vulnerable aspects of pests. Information on economic importance is essential for apportioning research efforts, and an understanding of economic thresholds can avoid unnecessary applied control. Cultural practices can reduce the numbers of certain insects at minimal costs. Plant resistance has been effective, economical, and readily acceptible for some cereal pests and is deserving of increased effort on a long term basis. Biological control has good potentials since many small grain pests are introduced. All of the above control approaches can protect and improve the quality of our environment. However, insecticides will continue to be the main control for some pests and are the only effective way to combat outbreaks. Thus, research efforts on pesticides could produce more efficient, safer, and cheaper chemical applications. Sterilization can greatly reduce or possibly eradicate a pest. The ensuing prevention of crop losses by pest eradication can far exceed initial cost although these may be comparatively great. The study of foreign pests as potential threats to the

growing of small grains in this country can best be done in coordination with other regions in the United States. Valuable knowledge could be obtained to prevent or soften the impact of introduced devastating insects which are known in foreign countries. The various components of insect activities, potentials, and control procedures can be systematically analyzed and pest management practices instigated with reduced production costs, reduced environmental hazards, and the alleviation of most of crop losses from insects.

CONTROL OF DISEASES AND NEMATODES

RPA 208

Situation

Wheat and other small grains are subject to an array of fungal, bacterial, and virus pathogens. These pathogens impose greater limitations on production in the Southern Region than in other regions of the United States because the long season favorable for plant growth also favors the pathogens and the diseases they cause. In the Oklahoma-Texas area, streak mosaic, leaf rust, and septoria leaf blotch of wheat, crown rust and yellow dwarf of oats, and net blotch of barley are the most obviously devastating diseases. In the soft red winter wheat area, leaf rust, mildew, barley yellow dwarf, and glume blotch are most conspicious in wheat; crown rust and barley yellow dwarf in oats; yellow dwarf and mildew in barley; and leaf rust and anthracnose in rye. In addition to these obvious diseases, there exists a cordon of diseases whose symptoms and effects are subtle, similar, and confusing. Examples include the effects of root rots, bacterial blights, and aphid damage. Early infection of oats by the halo blight bacterium causes red leaf symptoms easily confused with symptoms of barley yellow dwarf virus and also causes late winter killing of oats which is usually attributed to cold damage. In wheat, root rot and septoria crown infection are confusing and the impact of septoria in the crown and lower nodes is poorly understood. Thus, the failure to diagnose many diseases has resulted in a minimum of effort devoted to their control. Resistance to many of these diseases is available but has not been utilized. For example, use of the genes, Psc-2 and Psc-3 for resistance to bacterial blight might eliminate much of the red leaf problem in oats. In barley, genes for resistance to yellow dwarf and helminthosporium diseases have been discovered but not used.

The progress made in utilizing genes for resistance to rusts, mildew, victoria blight, and soil-borne mosaics results from the reaction of the plants to the pathogens being easily followed through breeding procedures. But many genes for resistance to other diseases are not being fully exploited. Therefore, emphasis should be placed on the utilization of these genes by incorporating them into stocks used in programs where breeding for rust, mildew, and soil-borne virus resistance are now in progress.

Historically, genes for resistance to the major diseases of small grains have been incorporated singly into new varieties with resistance to selected strains of the pathogens as the immediate goal. This practice has applied selection pressure to the propagative units of the pathogens and caused the build-up of existing but previously unimportant strains, or forced, by various means, the evolution and increase of new strains to levels of epidemic consequence. As a result, genetic resistance of varieties to important diseases at any given point in time is usually dependent upon a single gene. Thus, new approaches to varietal development and gene management are needed to introduce genetic diversity in the plant populations and to stabilize the pathogens.

The use of chemicals to control diseases of small grains has, with the exception of seed treatment, been uneconomic in the past due to a number of limiting factors. Disease control has been restricted to breeding resistant varieties and manipulation of cultural practices. However, recent advances in pesticide application and development, particularly of the systemic type, show promise for the control of a number of major diseases, notably the rusts, smuts, and mildews. Most of the newer systemic fungicides are effective in low concentration, easy to apply, relatively inexpensive, essentially non-toxic to plants and animals, and degrade into non-hazardous materials in the environment. The recent withdrawal of the widely used organic mercury seed treatment compounds has also created a pressing need to develop suitable replacements for these highly effective, broad-spectrum pesticides. Furthermore, increased restrictions on the testing of experimental pesticides will require greater cooperation of state and federal scientists with the agricultural chemical industry in the development of new compounds.

Numerous factors, including climate, cropping systems, air currents, and inherent characteristics of the plants and pathogens themselves, interact to initiate and sustain the development and movement of epidemics. Controlled management of epidemics depend upon understanding their evolutionary factors, early detection of biological and climatological conditions conducive to rapid disease development, and a prepardedness to respond quickly when the signs portend a hazardous situation.

Some disease situations also involve biologic vectors such as insects, nematodes, and fungi which transmit the pathogen from host to host. A major small grain disease of this type in the south is caused by barley yellow dwarf virus which is transmitted by several aphid species. Much information on the interrelationships of such organisms has already been obtained from previous research on several small grain diseases. Many of the hosts, pathogens, and vectors are well adapted for these studies, and individuals and techniques for making such studies are available. The information which could be obtained from continuing and enlarging these investigations would be invaluable in developing additional methods of disease control.

Damage caused by nematodes is currently recognized in wheat in Oklahoma, Texas, Arkansas, and Kentucky. In Oklahoma and the Texas panhandle, wheat is stunted in small circular areas of 0.1 to 0.5 acres by the stunt nematode, Tylenchorhynchus brevidens. In Oklahoma, primarily,

there exists a soilborne disease complex involving Pratylenchus minyus and several species of soilborne fungi. In both Arkansas and Kentucky, the increasing use of soybeans and wheat in a double cropping program has resulted in increases of Hoplolaimus sp. and Helicotylenchus sp. in wheat. Factual information as to the extent of loss or other economic impact information has not been collected systematically. Barley is severely damaged by the root-knot species Meloidogyne naasi in other regions but no reports of such damage have been made in the southern region. Other small grains are associated with a number of species of ectoparasitic nematodes which may build up when these crops are used in rotations but no economic loss is reported.

Economically important diseases of wheat and other small grains occur in foreign countries but have not been identified in the United States. For example, Karnal bunt caused by Neovosia indica and a leaf blight caused by Alternaria triticina are important fungal diseases of wheat in India. Unconfirmed reports indicate that Karnal bunt may have been found recently in Mexico. Several vector transmitted virus diseases in foreign countries, including Enansismo (drawfing) in Columbia and Ecuador, wheat stunt in South Africa, wheat dwarf in Czeckoslovakia, winter wheat mosaic in Russia, and northern cereal mosaic in Japan are potential hazards to small grains in the United States. Reactions of most sources of germ plasm used in breeding new cereal varieties for the southern region to the aforementioned and other foreign pathogens are unknown. Additionally, the host ranges of many foreign pathogens have not been determined among the native flora, nor have indigenous insects been adequately tested for their efficacy as vectors or predators of vectors. In the southern and other regions, damage to small grains from introduced pathogens only can be assessed a priori. But the potential losses that could result from the introduction of dangerous pathogens and virulent strains of pathogens, now present or likely to be found in foreign countries, are too devastating to leave unchallenged at a time when world food production is at its highest priority in the history of modern man.

Objective

To maximize grain and forage production by decreasing losses caused by plant diseases and nematodes.

Researchable Problems - 36 SMY

A. Decrease vulnerability to disease by increasing genetic diversity.

1. Increase resistance to the less spectacular diseases by utilizing available but commonly ignored genes for resistance. 4 SMY

2. Identify new sources of resistance in small grains and related genera and species to various pathogens. 2 SMY

3. Evaluate unique gene action which retards disease development through reduced inoculum production caused by low lesion numbers, "slow rusting", "slow mildewing", etc.
2 SMY

4. Determine the mode of inheritance of resistance to pathogens.
4 SMY

5. Emphasize the search for minor or modifying genes for resistance and evaluate their effectiveness in various combinations.
2 SMY

6. Study methods of prolonging effective gene protection through combined use with pesticides and crop management practices.
0.5 SMY

7. Combine major genes for resistance in various combinations to increase the duration of their effectiveness.
2 SMY

B. Evaluate methods of using pesticides to control small grain diseases.

1. Determine the best methods, rates, and times of application of pesticides.
1 SMY

2. Study the integration of pesticides use with disease resistance and cultural practices.
0.5 SMY

3. Evaluate the effects of pesticides on the plant and its environment.
0.5 SMY

4. Cooperate with chemical industries in the development of more effective pesticides.
0.5 SMY

C. Identify and evaluate factors controlling the initiation, development, and movement of disease epidemics.

1. Determine the host ranges and life cycles of pathogens virulent on wheat and other small grains.
2 SMY

2. Identify and evaluate environmental ecological, biological, and other factors affecting the sources of inoculum initiation, rate of development, and movement of epidemics.
3.5 SMY

3. Study the effect of various host genes for specific and general resistance on development and progress of epidemics.
2 SMY

D. Develop a better understanding of host-pathogen-vector relations for developing the most effective methods of disease control.

1. Develop or identify either isogenic host lines or varieties with known genes for disease resistance.
1 SMY

2. Acquire cultures of pathogens, vectors, and alternate hosts with specific characters involved in problem diseases.
0.5 SMY

3. Study the genetic physiologic, morphologic, histologic, and serologic relations among hosts, pathogens, and vectors.
2 SMY

4. Implement inter- and intraregional cooperative studies between federal and state personnel on specific problem diseases.
0.5 SMY

E. Determine the economics of nematode damage to wheat and small grains by field and greenhouse evaluations of the effects of individual nematode species and assist plant breeders in developing nematode-resistant breeders stocks.

1. Study the basic biology and determine the economic loss in wheat as grain and forage in Oklahoma due to the effects of nematodes and fungi under different crop successions.
1 SMY

2. Evaluate the significance to wheat as grain and forage of the build-up of nematodes as the result of double cropping with soybeans in Arkansas and Kentucky.
0.5 SMY

3. As a regional project, determine the effects of the significant nematode parasites of wheat and small grains on the available breeding stocks and the distribution of significant crop loss over the region.
2.0 SMY

F. Determine the reaction of U. S. varieties, advanced and early generation lines, and sources of germ plasm (including non-cultivated genera and species) to foreign pathogens and estimate the damage they could cause if introduced into the United States.

1. Participate in the National Plant Detection and Information Program to survey the region for previously unidentified or introduced pathogens.
0.5 SMY

2. Institute cooperative international nurseries with breeders and plant pathologists specifically for assessing the reactions of varieties, lines, and germ plasm sources to foreign pathogens in areas where they now occur.
   0.5 SMY

3. Establish in cooperation with scientists in other regions and in foreign countries an isolated research facility where relations among crop plants, pathogens, vectors and potential vectors, and reservoir plants could be studied.
   1 SMY

Potential Benefits

The foregoing research objectives and approaches have the potential for increasing yield and forage qualities of winter oats and barley, and yield and quality of winter wheat. It is possible that a successful execution of these approaches would make small grains more acceptable to southern farmers and grain processors. There is no way to estimate the dollar value of such a program but there is little doubt that significant increments of grain yield would occur and that the deficit of grain production in the Southern Region would be lessened.

WEED CONTROL IN SMALL GRAINS

RPA 209

Situation

It has been estimated by the Southern Weed Science Society that serious yield losses occur on over 6 million acres of small grains grown for grain in the southern region of the U.S. The loss due to yield reductions is estimated at $33 million annually. If the cost for herbicides, loss in grain quality, extra tillage and cultivation needed, decrease in land value, and added harvesting problems are considered, the total loss in small grains due to weeds in the southern U.S. is over $78 million annually. The losses in Oklahoma and Texas are $50 and $18 million, respectively, and this amounts to 87 percent of the losses for the entire south.

Most species of weeds grow successfully under a variety of conditions. Due to the diversity of environmental conditions across the south, varying from the humid east with over 50 inches of rainfall per year to the semi-arid west with 18 inches of rainfall annually, there is a wide diversity of weed species that are problems in small grains. For the last 25 years, 2,4-D has provided effective control for many of the annual broadleaf weeds in grains. However, winter annual grasses, perennial grasses, and perennial broadleaf species are becoming greater problems. Tansy, wild, and treacle mustards cause considerable problem. Although these are susceptible to 2,4-D used at the proper growth stage, insufficient treating has been done by farmers to date. Henbit, spiny sow thistle, field

bindweed, wild buckwheat, and wild garlic are other broadleaf species that cannot be successfully controlled with 2,4-D and are becoming greater problems. In the western part of the region species such as jointed goatgrass, cheat, downy brome, and little barley are increasing in prevalence. Considering all the states in the south, mustards are a problem in nine states, henbit in eight, chickweed in seven, curly dock and thistles in five, and wild garlic, cheat, and little barley in four.

Due to the limited financial support for research, little is known about the ecology of weeds in relation to their growth, reproduction, and competition with small grains. Presently there is a total of 0.5 SMY and 16,151 dollars spent annually to conduct research on problems related to weed control in small grains.

Growers have traditionally used cultural practices as the major procedures for controlling weeds which compete with small grain crops. These have been fairly effective in the past but do not prevent many types of weeds from becoming problems. The addition of herbicides to the overall cultural small grain practices has increased the ability of the grain farmer to grow the crop in spite of weed problems. Where management practices are selected for complimentary action with herbicide treatments, the crops are better able to compete with the weeds.

Objective

To study the biology and ecology of troublesome weeds in small grains and to develop improved cultural and chemical practices for their control.

Researchable Problems - 5 SMY

A. Study the growth habits and ecology of troublesome weeds and more carefully assess losses caused by them in small grains.
2 SMY

B. To develop more effective chemical weed control treatments, and to study the influence of herbicides on crop quality while reducing the potential for crop and environmental damage.
2 SMY

C. To better integrate chemical and cultural practices into effective programs for weed control in small grains, and to also integrate these practices with other pest control procedures needed for the crop.
1 SMY

Potential Benefits

The development of improved weed control practices in southern small grains should reduce weed losses from reduced yields, poor quality, extra cultivation, decreased land value, and increased harvesting costs by at least 25 percent. The development of these practices should aid the farmer in integrating all of his pest control practices into a single system, with reduced costs and increased benefits being derived. It should also reduce the potential for environmental contamination as a result of improper pesticide usage in small grains.

IMPROVED BIOLOGICAL EFFICIENCY
OF FIELD CROPS

RPA 307

Situation

The performance level of a crop variety reflects the maximum production potential of its genotype under the prevailing environment. Two avenues to improved biological efficiency of a crop are available to plant scientists. First, by manipulating the genetics of the crop, the yield potential of varieties may be enhanced. Second, advantage of yield potential can be realized when environmental and ecological parameters which confine or suppress the full genotypic expression are identified and controlled.

Available evidence indicates that no yield limit in terms of genetic improvement has yet been reached in the small grain crops. Basic studies in genetics, cytogenetics, and mutation breeding serve to guide breeding programs and should be expanded.

Breeding programs based on efficiency levels of biochemical and physiological systems within the plant offer great possibilities for maximizing production potential, yet little is known about the genetic control of these systems. Chromosome engineering techniques have been used effectively to transfer genes and gene complexes for pest resistance from alien species. The use of these techniques should be extended to include other traits such as drought tolerance and general vigor. The induction of mutations by irradiation may be necessary for the development of new germplasm not available in natural populations. This aspect should be investigated.

New or modified breeding systems may result in increased effectiveness in varietal development. Breeding systems based on individual components of grain yield may be of value. Varieties differ as to the relative magnitude of these components which include number and size of head and seed weight. The optimum balance of yield components needs to be determined for particular production situations and component analyses could be used to guide breeding systems. The possibility of utilizing heterosis in small grains warrants further investigation. Research on wheat hybrids has been conducted for 10 years, but problems still exist; particularly those involving pollen control mechanisms. There is a strong possibility that forage yields in rye can be increased by the use of hybrids or strain crosses and this aspect should be investigated in more depth. Improved screening methods are needed for the development of small grain varieties with tolerance to aluminum toxicity and to other trace elements as well as to herbicides and insecticides. Methods need to be perfected for more efficient handling of larger breeding populations and for reducing the time required for variety development. The prediction of results from breeding programs concerned with grain yield and its components is extremely difficult. A recent classification of polygenic systems affecting these characters in oats offers an approach to this problem which can be extended to other small grain crops.

Plant breeding programs are based on the existence of genetic variation within the species and continued success in variety development depends on the availability of a genetically diverse gene pool. The USDA maintains a world collection of small grains which represents some 90 percent of the world's variation. Efforts should be made to add new genes to this collection. A systematic program of germplasm evaluation is needed for the Southern Region. It is essential that the gene base of small grain breeding programs in the south be broadened to reduce the risks of genetic vulnerability and to provide for higher levels of genetic improvement.

Various physical and chemical soil characteristics, including extremes in acidity and alkalinity, influence yields, enhance deficiencies and toxicities of minor elements, and regulate populations of soil microflora including soilborne pathogens. Throughout the region, yields of wheat and other small grains have been increased steadily by breeding improved plant types and changing management techniques. These changes have, in themselves, introduced new management questions and indicated possible methods of further increasing the biological efficiency. Short stature wheat varieties that resist lodging have become common in recent years but inadequate attention has been given to their root development and relative tolerance to drought. In some areas, closer spacing between rows of short varieties than was recommended for the old tall ones may increase the number of culms per unit area with a proportionate increase in yield. Also, new and anticipated changes in plant types present new problems relating to fertilization rates, time of seeding, and irrigation which must be solved if maximum advantage of the genetic potential for production is realized.

Objectives

To optimize genetic potential through breeding and cultural practices to maximume grain and forage production of small grain crops.

Researchable Problems - 49 SMY

A. Breeding for increased grain yield potential.

1. Hard Red Winter Wheat - Develop high yielding varieties which possess desirable production attributes which include tolerance to drought and temperature extremes, resistance to major disease and insect pests, high grain protein content, good bread-making quality, and strong straw.
6 SMY

2. Soft Red Winter Wheat - Develop high yielding, short strawed, early maturing varieties which are suitable for double-cropping with soybeans or sorghum. These varieties should possess desirable production attributes including inherent resistance to major disease and insect pests, and good flour quality.
6 SMY

3. Oats - Develop high yielding, winterhardy oat varieties which are resistant to major disease and insect pests and other production hazards. Breeding efforts should be directed toward improving grain protein content and improving the nutritional value of the grain.
   4 SMY

4. Barley - Develop improved, high yielding winterhardy barley varieties which have desirable production attributes including strong straw, resistance to major disease and insect pests, large kernels, and improved nutritional quality.
   2 SMY

5. Rye - Develop, and release varieties or strains of rye which have high grain yield as well as superior forage production, Breeding efforts, should be concerned with resistance to major diseases and insects, drought tolerance, reducing seed deterioration, and improving stand establishment.
   1 SMY

6. Triticale - Develop adapted triticale varieties which have high grain yield as well as increased forage production. Breeding efforts should be directed toward winterhardiness, improved physical kernel characteristics, early maturity, strong straw, high protein, lysine, and better nutritional quality.
   1 SMY

B. Breeding for increased forage production.

1. Breed, evaluate, and release (a) varieties of small grains with superior forage production and grazing performance and (b) varieties that combine superior grazing characteristics with high grain yield for use in dual-purpose grazing and grain production systems.
   2 SMY

2. Develop more efficient screening methods for better evaluation of forage potential. Perfect micro-plot and small scale tests for screening large numbers of breeding lines for forage characteristics.
   1.4 SMY

3. Investigate the effects of diseases and insects on forage production particularly with regard to regrowth characteristics under a grazing system.
   1.2 SMY

4. Investigate nutritional quality of small grain forage.
   1 SMY

C. Breeding systems.

1. Determine the optimum balance of yield components (tillering, head size, and seed size) for important production areas and management systems and through breeding, develop varieties with an architecture consistent with maximum performance.
   2 SMY

2. Study the possibility of utilizing heterosis in the small grain crops. Pollen control systems including cytoplasmic male sterility, genetic male sterility, and chemical gametocides should be investigated.
   .7 SMY

3. Investigate novel breeding procedures such as those based on enzyme activity or physiological efficiency. Explore the use of pollen culture and parasexual hybridization as possible breeding tools.
   1 SMY

4. Determine the extent of genotype - environment interaction for grain yield and forage production. If necessary, develop varieties adapted for specific areas of production and/or specific management systems.
   .7 SMY

5. Develop more effective methods to screen for tolerance to aluminum toxicity and to other trace elements as well as to herbicides and insecticides.
   .3 SMY

6. Study methods and procedures to make breeding programs more effecient and effective and consider breeding modifications that will reduce the time required for variety development.
   .4 SMY

D. Genetic, cytogenetic, and mutation approaches to breeding.

1. Establish the genetic basis of biochemical and physiological systems important in growth and development processes in small grains.
   3.3 SMY

2. Using chromosome engineering techniques, transfer desirable genes, and gene complexes from wild relatives to the cultivated plants.
   1.5 SMY

3. Investigate the potential of genetic change and production of new and diverse germplasm through radiation techniques.
   .5 SMY

E. Germplasm resources.

1. Study methods to broaden the gene base of small grains (especially triticale) in the Southern Region for improvement in production, quality, and to decrease genetic vulnerability.
   1 SMY

2. Cooperate with the USDA World Collection program and the National Seed Storage Laboratory to assemble and preserve new and potentially valuable germplasm for use in breeding programs.
   1 SMY

3. Organize a system of germplasm evaluation and exchange among workers in the Southern Region as well as those in other regions.
   .6 SMY

F. Organize and establish in the Southern Region uniform performance nurseries of all small grain crops. Performance data should be made available to all workers in region.
1.4 SMY

G. Determine optimum plant density, spatial relations, rates and kinds of fertilizer, irrigation methods, and soil management practices for specific varieties, environments, and cropping systems to produce grain and forage.

1. Determine optimum seeding time, plant spacing, and plant density for maximum production of forage and grain.
   3 SMY

2. Develop soil management practices to decrease the problems associated with excess acidity and alkalinity.
   1 SMY

3. Determine the relative water use efficiency among varieties, stocks, and germ plasm sources.
   1 SMY

4. Determine the most effective methods and rates of applying fertilizer elements in the various small grain producing areas under different cropping systems.

5. Determine the optimum timing and amount of water applications to small grains in irrigated areas.
   1 SMY

Potential Benefits

Each researchable problem suggested for improving biological efficiency would potentially result in an increment increase in yield. The limits to increased yields by genetically recombining yield components, modifying plant architecture, enhancing tolerance to drought, and improving disease and pest resistance are unknown. Currently, there are experimental lines in southern breeding programs which have demonstrated yield potentials as high as five times that of the commercial average for the area. Added to genetically derived benefits, increased efficiency accrued through management and cultural practices should significantly increase yields. Although impossible to presage in accurate terms the full consequences of the proposed research, a 20 percent yield increase over current production is a conservative estimate of expected returns ten years hence.

MECHANIZATION OF PRODUCTION OF FIELD CROPS

RPA 308

Situation

Present systems of mechanical tillage for weed control during fallow periods between annual or bi-annual crops of wheat and other small grains leave the soil bare and subject to erosion. This problem is most intense in climatic areas where winter annual grass weeds are a problem. Sweep tillage that conserves crop residues on the soil surface is effective in semi-arid areas but does not control grasses. Moldboard plowing is more effective in controlling weeds but leaves the soil bare. The challenge then is to develop new combinations of cultural practices and herbicide uses where plant residues are maintained on the soil surface while weeds are controlled between and in small grain crops. This would lead to maximum yield and profit.

Objective

To develop systems of tillage and weed control where maximum residues are conserved on the soil surface for erosion control and soil moisture conservation while weeds are controlled and small grain yields maximized.

Researchable Problems - 6 SMY

A. Determine for individual soil types the amount of mechanical manipulation necessary to create and maintain optimum soil physical condition, while maintaining surface residues and minimizing heavy machinery, traffic, and develop standards to describe this circumstance.
4 SMY

B. Determine the effects of minimum tillage culture on the reactions of varieties, fertilizer, diseases, and insects.
2 SMY

Potential Benefits

There are three problems in agriculture that minimizing tillage or maximizing the concept of conservation tillage could alleviate.

A. Presently, agriculture and associated soil erosion is the worst polluter of water in the country. Effective systems of minimum tillage would markedly reduce erosion by both water and wind.

B. Minimizing tillage would reduce fuel requirements.

C. Minimum tillage systems will reduce labor requirements for small grain production.

PRODUCTION MANAGEMENT SYSTEMS FOR FIELD CROPS

RPA 309

Situation

Maximum productability in small grain production results from combining all the improved cultural practices into an integrated system for each soil and climatic situation. Cropping systems and tillage procedures must be developed for maximum production efficiency while at the same time maintaining or improving soil productivity and the quality of the environment. Sediment production and other pollution of water, air, and soil must be considered when developing production management systems.

Fuel and fertilizer shortages with the sharp rise in prices of these production tools creates heavy new demands for information on ways to use these resources most efficiently.

Mathematical models are being developed and used to simulate small grain growth and predict yields with a given set of cultural practices and soil management systems. These efforts hold promise for integrating needed sets of management inputs but available reliable data are often too limited to allow adequate use of this technique. These models are useful in identifying factors requiring additional research. Another approach to increase production may be the use of chemicals to increase the yields or quality of existing small grain varieties. A new family of chemicals, called plant growth regulators, show potential for doing this. Plant growth regulators, some of which cause striking changes in normal development patterns, work within the biochemical systems of the plant. If a growth regulator could be found that would increase the yield or the

quality of small grains easily and inexpensively, the potential benefits to man would be great. Increased yields of wheat by growth regulators have been reported in certain areas of the world and some are in use in Europe. However, limited information is available on use of growth regulators in the southern United States. The majority of past studies in grains have utilized 2-chloroethyltrimethylammonium chloride (CCC). Some of the plant properties that have been shown to be effected by growth regulators include stem height and thickness, less surface area, kernel weight, kernels per spike, spikes per plant, total grain yield, and grain protein content. Shortening of the stem as a result of a shorter internode and a thickening of the stem has been found in some limited research in the southern U.S. This could have a significant effect on lodging of grains. In areas of high rainfall with high nitrogen fertilizer rates reduced lodging could in itself result in increased yields.

Objectives

To improve the quantity, quality, and efficiency of small grain production through the development of improved management systems, potentially including the use of plant growth regulators.

Researchable Problems - 6 SMY

A. Utilize computerized systems analysis to develop cropping systems compatible with soil and climatic areas.

B. Determine optimum timing and amount of water application to small grains in irrigated areas and develop practices for higher moisture use efficiency under dryland conditions.
1 SMY

C. To study the influence of growth regulators on the vegetative growth, yield, and nutritive quality of wheat and other small grains.
1 SMY

D. Determine the profit maximizing intensity and combination of inputs.
.5 SMY

E. Seek ways to raise management know-how of small grain producers.
.5 SMY

F. Determine the economic benefits of production alternatives available, given increased fertilizer and energy costs; increased restrictions on the use of pesticides; alternative cropping systems; and alternative grazing practices required after pesticide applications.
1 SMY

Potential Benefit

The time period between 1972 and 1974 demonstrated large and dramatic changes in input and output price relationships, some of which can be expected to continue in the future for wheat and small grains. The trend of input prices is increasing, and price relationships are ever changing for inputs such as energy, fertilizer, and other chemicals, machinery, land, labor, and water. These conditions necessitate the development of optimal management systems.

Growth regulators have the potential for rapidly increasing protein supplies while plant breeders are developing improved varieties. However, any such practice would need to be carefully integrated with current production procedures in southern small grains.

PRODUCTION OF FIELD CROPS WITH IMPROVED ACCEPTABILITY

RPA 405

Situation

The basis for commercial and nutritional quality differs in kind and degree from product to product. Additionally, a wide range of parental material is constantly being introduced into breeding programs and the range of quality characteristics shifts accordingly. Regardless of the quality objective of a development program, readily available quality determinations which can be conducted in early generations when seed supplies are limited are essential.

Quality problems in both the hard red winter wheat (grown in Texas and Oklahoma) and the soft red winter wheat (grown through the rest of the Southern Region) relate to criteria associated with their end use. While the hard wheats are commonly used for bread flour which is valued for its high protein content, strong gluten and high water absorption, the soft wheats are well suited for producing finely granulated flour for use in chemically leavened pastry goods. The flour from soft wheats is generally valued for low protein, mellow gluten and low water absorption. Neither and Hard Wheat Quality Laboratory, at Manhattan, Kansas, nor the Soft Wheat Quality Laboratory, at Wooster, Ohio, is in the Southern Region but both facilities offer valuable laboratory evaluation programs which are necessary to meet the needs of the breeding program.

A close liaison between wheat breeders and the milling industry is especially important if new, divergent sources of germ plasm are to be utilized to their maximum. While milling standards are generally quite inflexible, a better understanding by the industry of the potential value of divergent types might well lead to a greater willingness to adjust milling procedures to accommodate them.

Oats are produced in the Southern Region as both a seed crop and a forage crop. In both cases the quality of the product is important. The discovery of high protein in A. sterilis (a wild oat type introduced to American programs from Israel) has sparked a special interest in increasing the already well balanced protein found in oat groats. The Oat Quality Laboratory at Madison, Wisconsin, provides an important service in evaluating small samples from early generation breeding material. It is also developing into a center for basic research relating to grain quality.

The barley produced in the Southern Region is utilized almost entirely for feed. Proper amino acid balance is important and studies designed to provide a better understanding of amino acid metabolism are most appropriate. The production of malting barley has never proved feasible in the Southern Region but there is now some interest in Oklahoma. If a market develops in that area, close cooperation with the Malting Quality Laboratory, Madison, Wisconsin will be desirable.

Objectives

To study and improve the factors contributing to grain and forage quality, as well as flour products, of wheat, oats, and barley and to apply this knowledge to varietal improvement programs and commercial and public needs.

Researchable Problems - 5.0 SMY

A. Study fundamental factors responsible for differences in wheat quality and incorporate quality characteristics through breeding.
2.0 SMY

B. Evaluate specific forage products as potential components of specific livestock rations.
1.0 SMY

C. Study physical and chemical aspects of amino acid metabolism in barley.
1.0 SMY

D. Transfer the high protein from wild oats to cultivated oats through plant breeding.
1.0 SMY

Potential Benefits

Efforts to maximize the quality of the small grain produced in the Southern Region will also contribute to an associated increase in value. The dollar value of quality improvements are difficult to assess, but a few cents per bushel at the market reflects a significant influence upon the agricultural economy.

QUALITY AND QUANTITY MAINTENANCE OF WHEAT AND OTHER SMALL GRAINS AND THEIR PRODUCTS DURING MARKETING

RPA 408

Situation

Microorganisms, insects, and rodents have been estimated to consume over 10 percent of the weight of grain between the time of harvest and consumption by people or livestock. In addition, there can be a deterioration of quality that is difficult to measure and cannot be accurately estimated on a world-wide basis. Losses occur in storage on farms, elevators, and processing plants. Problems are also associated with transportation of grain within the United States and shipment abroad. A separate task force will deal with storage pests so this report will pertain mainly to wheat and other small grains storage problems related to the producers of grain for food or feed and for seed.

A survey showed that only about 48 percent of wheat samples reached the mills without internal insect infestations. Most infestations originate after harvest but some areas of the Southern Region have conditions favorable to field infestation since some pests are of semi-tropical origin. Insect pests have certain temperature, moisture, and food requirements which directly affect their abundance. Better harvesting and farm-handling procedures can help to alter conditions favorable for insect invasion and multiplication. For example, some pests cannot become established in grain with low moisture content and some are confined mainly to cracked kernels. Some insects are especially damaging to seed supplies because they attack mainly the germ. Seedsmen handling or storing bulk seed or carrying over supplies from one season to the next are subject to significant losses due to reduced seed germinability.

Objective

To determine optimum mechanical and environmental conditions for harvesting, handling, and storing wheat and other small grains with minimal losses from pests.

Researchable Problems - 12 SMY

A. Investigate the interactions of microorganisms and insects.
4 SMY

B. Devise harvesting and handling equipment that produce less grain injury and better drying of seed.
4 SMY

C. Develop better physical and chemical measures for combatting insect pests of seed for planting and processing.
4 SMY

Potential Benefits

The reduction of weight loss and the maintenance of quality of wheat and other small grains during marketing could preserve valuable food sources. In fact, savings could be sufficient to supply much of the food needs of famine areas of the world. Any non-chemical means of insect control would help to protect the environment. There could be benefits to producers, processors, consumers, and exporters of grains.

IMPROVEMENT OF GRADES AND STANDARDS

RPA 501

Situation

The steady growth in U.S. feed grain exports for the past fifteen years and the rapid increase of the past two years has been the result of many factors exerting an influence on total demand. Although some factors are of a short-run nature, the historical pattern of growth shows a definite increasing trend, and the underlying changes in effective demand that have occurred in many countries suggests a continued growth of feed grain exports from grain producing states in the Southern Region. The rapidity with which demand has expanded in recent years has created a temporary emphasis on quantity that completely overshadows concern for quality. However, the long-run position of the United States grain industry in world trade and international relations depends on our ability to supply buyers and ultimate users of grain with a high quality product. To maintain a competitive position and assure continued growth in demand for U.S. grains, the grain industry must provide buyers with those quality characteristics that are of economic importance.

Information is needed to identify the quality factors of economic importance to various buyers and users in the U.S. and major grain importing areas of the world. Grades and standards in the marketing systems should provide meaningful communication with respect to quality of the product in relation to its price and use. Research is needed to identify a system of marketing that permits buyers to reflect their relative preferences for grain of various characteristics in the pricing system. The market system must then communicate these price differentials back through each stage of the marketing channel to the producer. Where the preference for quality, as communicated in price, is greater than the cost of producing and maintaining that quality, the marketing system should permit and encourage production and preservation of the highest quality grain that is economically feasible.

Research is needed to identify quality factors desired by buyers in the U.S. and other countries and the price differential they are willing to offer for each quality factor. Also, there is a need to study the market system which uses grades and standards to communicate quality preferences and price differentials back to the producer. Because of the importance of federal grades and standards in domestic and foreign trade, grading principles and practices need to be a major portion of the study of this marketing system. If grades and standards are to continue to play an important role in domestic and export trade, they must accurately describe grain in terms that are relevent to the ultimate user when determining the value of each lot of grain offered for sale. These ultimate users may vary from foreign buyers to domestic grain processors or livestock feeders, each of which can then communicate their quality preferences through price differentials. Objective, quick, and accurate measures for quality characteristics of economic significance are needed along with increased automation in communicating this information.

Wheat, barley and oats are traded in the U.S. on the basis of official grades, which are determined by factors including test weight, moisture, damaged kernels, and foreign material. Protein content is used in marketing wheat and malting barley, but it is not a part of the official grain standards. Low cost and accurate methods of testing protein content at country buying points are not available. A system of grades and standards which recognize protein content, milling yield, and other meaningful quality factors should be developed and established.

Objectives

To identify those quality factors desired by buyers in the U.S. and other countries and those price differentials offered for each quality factor. To develop grades and standards that will quickly and effectively communicate value differences for varying gradation of quality factors.

Researchable Problems - 6 SMY

A. Develop a data series for identifying major grain producing countries and grain importing countries by type of grain in order to select the geographical regions of greatest importance for the study.
.5 SMY

B. Identify the different types of major users by type of grain in the countries selected for study. Use total bushels of grain as the criterion for ranking the importance of the different grains for food, livestock feed, and industrial processing.
.3 SMY

C. Obtain a quantitative comparison of quality characteristics that each user considers to be important in determining the final values of grain. Correlate the quality characteristics obtained with quality factors in current grades and standards.
2.2 SMY

D. Compare the quality of grain at the point of production with the quality received at final destination and identify changes in quality at each point in the marketing channel.
1.0 SMY

E. Evaluate the effectiveness of existing grades and standards in serving the needs of sellers and buyers and for reflecting different gradations of quality which affect value and use.
1.0 SMY

F. Develop descriptive terminology for grades and standards which will characterize different quality factors of wheat and other small grains and their products, to facilitate communication between buyers and sellers at each point in the marketing channel.
.3 SMY

G. Develop methods and establish one or more uniform systems of domestic and foreign grades and standards recognizing those characteristics which reflect value and affect use.
.5 SMY

H. Provide a set of discounting procedures that will permit price to accurately reflect the value in final use of wheat and small grains which have different quality characteristics.
.2 SMY

Potential Benefits

Improved price communication from the ultimate user back through the marketing channel to the producer would result from more precise terminology developed from requirements and preferences of ultimate users, and methods for describing and assessing the economic value of every degree of quality factor. Prices would more accurately reflect value and a more competitive position in the world market would result. Decreased sampling and sample analysis plus a more reliable inspection would be major benefits. Complete and reliable automated sampling and grading of wheat and other small grains is needed to reduce federal inspection costs, boxcar time, costs in boxcar trimming, economic losses due to downgrading and losses due to inaccurate sample analyses. Other benefits include improvement of the reputation of U.S. grain sold to foreigh buyers and aquisition of a greater knowledge of import quality restrictions imposed by importing countries such as mainland China, and thereby preclude unfortunate and uneconomic trade experiences.

EFFICIENCY IN MARKETING AND PRODUCTION INPUTS

RPA 503

Situation

An efficient marketing system for agricultural products is a national requisite. Each of the specialized national economies for wheat, small grains, and grain products is highly dependent upon the efficient performance of this marketing system.

The grain marketing industry in particular is being subjected to immense economic pressures to change. Changing U.S. domestic and foreign programs is the basis of one set of these pressures. A basic change in the thrust of government farm programs has injected many new and unknown elements that can affect the operation of the grain marketing institutions which, working together, constitute the grain marketing system. Other aspects of the emerging farm programs may affect the comparative advantage of various grain producing regions.

Adjustment to changing market conditions is a continuous process for grain processing and marketing firms.

The efficiency with which these adjustments are made often determines the profitability of particular activities of the grain industry in the future. In the past, relatively inflexible institutional arrangements and constraints have permitted few adjustments in the overall grain marketing system.

A rapidly changing economic environment has resulted in significant demands placed upon the grain marketing system. Factors such as population growth, changes in regional distribution of population, increased per capita income, recent expansion of wheat and small grain production, the increase in wheat exports from 632 million bushels during 1971/72 to 1.184 billion bushels during 1972/73, and the increase of feed grain exports from 796 million during 1971/72 to 1.258 billion bushels during 1972/73 indicate some of the changes taking place. These changes make it imperative that adjustments be made within the grain marketing system in order that it may be compatible and accommodating under changing economic situations.

Recent expansion of wheat and small grain production has been accompanied by shifts in market channels and outlets for wheat, small grains, and grain products. These shifts have been due largely to an overall increase during recent years in commercial and government-financed exports and to changes in patterns of national and international demand. Changes in transportation have filled the spectra from railroad financial crises and railline abandonment to revisions in the transportation restructure and development of alternative modes of transportation. Improved technology used in production, transportation, processing of grain and grain products, and other cost factors may interact to foster marketing inefficiencies in the grain marketing system. Adjustments may be needed in the

location, size, and number of storage facilities and processing plants because of changes in production areas and demand patterns. (New transportation technology includes not only Sea-Land and LASH systems, but also ocean tankers which currently vary from about 65 thousand to 100 thousand dead weight tons to giant ships planned which range in size from 250 and 500 thousand tons to 1 million ton tankers. The deepest water available at gulf ports is 42 feet. An 80 thousand ton vessel draws 44 feet of water while a 500 thousand ton vessel draws nearly 100 feet of water. At present, of the grain export port areas, only the Northwest, around the Puget Sound, has harbors of adequate depths to handle these giants.)

Objective

To determine those adjustments which are necessary for the establishment of an effective but flexible marketing system for wheat, small grains, and grain products that can operate at optimum efficiency under current changing economic conditions.

Researchable Problems - 13 SMY

A. Determine the effects of changing farm programs on the efficiency of marketing, utilization, and distribution of grain and grain products.
1.0 SMY

B. Determine the overall structure and performance of wheat, small grains and grain product markets by analyzing prices, marketing costs, margins, practices, and services.
1.0 SMY

C. Develop a matrix of multi-mode rates which would provide quick access to transportation rate data for use in analysing efficiency in the assembly and distribution of wheat, small grains, and grain products.
8.0 SMY

D. Determine the most efficient and economical system for handling, transporting, storing, and distributing current and projected supplies of wheat, small grains, and their products including the type, size, and location of facilities.
1.0 SMY

E. Determine those economic benefits which would accrue to the grain marketing industry through adjustments in grain marketing patterns, coordinating arrangements, and marketing agreements (for example contracts and holding actions) between producers, other members of the grain marketing system, and the ultimate user.
1.0 SMY

F. Evaluate the economic impacts of marketing innovations, new or improved products, and market development activities on wheat, small grains, and grain products from the ultimate user in both

domestic and foreign markets, back through the marketing channel to the producer.
1.0 SMY

Potential Benefits

Increased operational efficiency in producing, delivering to primary markets, processing, and distributing the national wheat, small grain and grain products would reduce the total cost of these processes and functions, save resources, and increase real national income. Total cost would be reduced not only for domestic users but also for foreign importers which would increase the comparative economic advantage of the U.S. grain industry in international trade. Previous research indicates that a minimum reduction of $261 million, or 19 percent of the marketing costs of the United States grain marketing system might be achieved.